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## (54) ELECTRICALLY DRIVEN EARTH-MOVING MACHINE

(71) We, CATERPILLAR MITSUBISHI LTD., a Japanese Body Corporate of 3-1, 3-chome, Marunouchi, Chiyoda-ku, Tokyo, Japan do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an electrically driven earth-moving machine.

According to the present invention there is provided the combination of an electrically driven earth-moving machine and an electric source car for supplying electrical power to the earth-moving machine, the electrically driven earth-moving machine comprising a chassis on which is mounted an electric motor as a main prime mover and a reeling device mounted at the rear of the chassis and having an electric cable wound thereon with one end coupled to the electric motor and the other end having a connector for connection to a suitable connector on the electric source car, the reeling device including a torque motor which is arranged to pay out and to wind-in the cable according to the distance between the machine and the electric source car, when separated.

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a side elevation of the combination of an earth-moving machine and an electric source car;

Figure 2 is a back elevation showing a reeling device provided at the rear of the earth-moving machine shown in Figure 1;

Figure 3 is an enlarged sectional view showing the connector; and

Figure 4, (a), (b) and (c) show examples of the operation of the earth-moving machine.

Referring to Figures 1 and 2, an earth-

moving machine 1 is connected with an electric source car 10 by a coupling 2. The machine 1 includes a motor (not shown), a reeling device 4 for automatic wind up of an electric cable, a torque motor 18 for controlling the reeling device, and a device 19 for controlling electric power.

As shown in Figure 2, the reeling device 4 is fixed to the rear of the earth-moving machine 1. The reeling device 4 is adapted to permit the wind up of an electric cable 6 of a predetermined length. The end portion 6A of the cable 6 is connected to the control device 19 which is wired to a main electric motor (not shown) and another electrical device (not shown). The other end 6B of the cable 6 is removably connected to a socket (not shown) of a switch 15 of the electric source car 10. The electric source car 10 includes a vehicle 10' having a box like frame equipped with a pair of tired wheels 9 and a free jockey wheel 17 for movement of the electric source car 10. The tired wheels 9 support the weight of the electric source car 10, and the free wheel 17 is lowered into contact with the ground when the electric source car 10 is in the stationary state. When the electric source car 10 is connected to the earth-moving machine and moved, the wheel 17 is raised from the ground. The free wheel 17 can be moved vertically by actuating a lift handle 16. In the vehicle 10', an engine 11 and an electric power generator 12 are arranged in series, and they are connected by a coupling 13. By the driving of the engine 11, electricity generated by the power generator 12 is transmitted to an electric cable 6. The engine 11 for use in the electric source car 10 may, for example, be an internal combustion engine using fossil fuel, such as a diesel engine. Accordingly, in the same way as ordinary earth-moving machines, construction work can be performed for prolonged periods of time by

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supplying fuel continuously.

The coupling 2 which connects the earth-moving machine 1 with the electric source car 10 has the following structure. A mounting member 2' is fixed to the rear of the earth-moving machine 1 below the reeling device 4, and to the mounting member 2' are secured two connecting plates 2'' at certain distance apart. On the other hand, on the side of the electric source car 10, a drawbar plate 7 is secured to the forward end of the vehicle 10' through the fitting member 5. As shown in Figure 3, the drawbar plate 7 is located between the connecting plates 2'', and they are connected by a pivot pin 8. When the pin 8 is removed, the plate 7 can be separated easily from the connecting plates 2''.

The earth-moving machine 1 is operated in an area which must not contain exhaust gases. The earth-moving machine and the electric source car are stationed apart from each other, and in principle, they are connected to each other by an electric cable. Since the electric source car does not include a driving device the electric source car is moved by using the tractive force of the earth-moving machine which provides sufficient tractive force for moving the electric source car. The coupling is provided between the machine 1 and the source car 10 in order to move the electric source car by utilizing this tractive force.

The operation of the earth-moving machine will be described below.

1) When the earth-moving machine is connected with the electric source car, the engine 11 is started by pushing a built-in start button on the switch 15 of the electric source car. With an increase in speed of rotation, electricity is generated from the power generator 12. The electric energy is transmitted to the control device 19 of the machine 1 through the cable 6. When the operator pushes a main switch of the control device 19, electricity flows in the main electric motor (not shown) of the machine. Subsequently, the machine is operated in a customary manner. When the earth-moving machine 1 moves forwardly or backwardly even to a slight extent, the electric source car 10 makes the same movement.

2) When the electric source car stays at a predetermined place, and only the earth-moving machine is operated:—

By removing the pin 8, the earth-moving machine 1 is separated from the electrical source car 10. In this case, the electric source car 10 is fixed to the above separated position. The machine 1 may make various manoeuvres by putting on the main switch of the machine. For example, when it is moved forwardly, the machine can be moved by a distance corresponding to the

limited length of the cable while releasing the cable wound on a rotating drum of the reeling device.

It is necessary to unwind or pay-out the cable when the earth-moving machine moves forward, but winding is required when it moves backward. The adjustment is made by an electric circuit of the torque motor 18. When the machine moves forward, the torque motor 18 rotates in the direction of unwinding the cable and when it moves backward, it rotates in the direction of winding the cable.

The torque motor is engaged with the reeling device 4. It is a drive source for releasing and winding up of the cable 6 thereby avoiding the possibility of damaging the cable by straining the cable pulling it off the drum and running over cable lying on the ground because it has not been wound-up as the machine reverses.

The construction work can be performed within a range defined by a circle drawn about the electric source car as a center with the whole length of the cable as a radius. During this time, if the electric source car 10 is remotely separated, the earth-moving machine is virtually silent and the electric motor is virtually noiseless. In the case of ordinary earth-moving machines carrying internal combustion engines, noises such as exhausting noises, normal running noises, accelerated running noises and the excavating noises of the operating device occur, but in the case of the electric earth-moving machine, the noises are of a low level and additionally there is no exhaustion of gases. By using the electric drive type machines, it is possible to locate only the electric source car 10 outside the area appointed by any anti-pollution regulations, while operating the earth-moving machine in such places as the residential area, hospitals, surroundings of schools, and tunnels to perform such operations as excavating, loading or unloading.

When it is necessary to park the electric source car 10 within the area appointed by anti-noise and anti-pollution regulations, the electric source car may be parked within a sound-proofed enclosure. In this case, it is possible to use a new building equipped with a soundproof device or provide a sound-proofing device within an already constructed building.

Figures 4, (a), (b) and (c) show the states of operation of the earth-moving machines in a tunnel. Figure 4 (a) shows the state of constructing a tunnel. The tunnel is communicated with the space above the ground by a vertical hole. In this case, the earth-moving machine is placed to operate at the innermost space of the tunnel, but the electric source car is parked at the surface. The electric cable 6 extends from the electric

source car to the earth-moving machine within the tunnel through the vertical hole. Figure 4 (b) shows the state of excavating a tunnel in which the earth-moving machine 5 is working while the generator unit is stationed adjacent to the entry. Both are connected with the electric cable 6. In the above two embodiments, exhaust gases do not come into the tunnel when the electric 10 source car is used.

At the tunnel boring site as shown in Figure 4, (c), a high voltage wire 20 for tunnel construction is provided within a gallery 26, and electric power required by 15 the earth-moving machine 1 may be obtained from this high voltage wire.

Power is transmitted to an electric source car in the form of a transformer 22 carried on a movable concrete arch 23, from the 20 high voltage wire 20 provided within the gallery 26. It is then changed to a predetermined voltage required for the earth-moving machine, and the power is then transmitted to a connector 21. Electric 25 power can be obtained by electrically connecting the connector 21 and the electric cable 6 of the earth-moving machine 1. With the advance of the excavations, the movable concrete arch 23 is also moved and 30 simultaneously the high voltage wire 20 is extended. Rocks and sands excavated at the gallery 26 are dumped onto a muck train 24 in a tunnel 27 through an opening 25.

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In order to release the electrical connection of the earth-moving machine 1 to 40 the electrical source car 10, a connector at the other end 6B of the electric cable is removable at the socket member (not shown) situated at an output terminal of 45 the switch device 15.

#### WHAT WE CLAIM IS:

1. The combination of an electrically 50 driven earth-moving machine and an electric source car for supplying electrical power to the earth-moving machine, the electrically driven earth-moving machine comprising a chassis on which is mounted an electric motor as a main prime mover and a reeling device mounted at the rear

of the chassis and having an electric cable 55 wound thereon with one end coupled to the electric motor and the other end having a connector for connection to a suitable connector on the electric source car, the reeling device including a torque motor 60 which is arranged to pay out to wind-in the cable according to the distance between the machine and the electric source car, when separated.

2. The combination according to claim 65 1, wherein the electric source car is provided with a power generating unit, and co-operating coupling means are provided on the back end of the chassis of the earth moving machine and the forward end of the 70 source car whereby the machine and car can be connected and released as desired.

3. The combination according to claim 2, wherein the power generating unit comprises an engine rigidly coupled with a 75 generator, an electrical device for transmitting electric power generated from the generator to the electric cable, and a switch.

4. The combination according to claim 2 or 3, wherein the electric source car com- 80 prises a box-like frame, at least one pair of tired wheels fitted one on each side of the frame, and a jockey wheel provided at the front portion of the electric source car, the jockey wheel being movable vertically 85 with respect to the frame.

5. The combination according to any one of claims 2 to 4, wherein the co-operating coupling means comprise a pair of spaced connecting plates mounted on the back of 90 the chassis, a draw plate mounted on the front of the electric source car, and a pin insertable through apertures in the connecting plates and the draw plate, when the draw plate is inserted between the con- 95 necting plates and the apertures are aligned, to couple the source car to the machine.

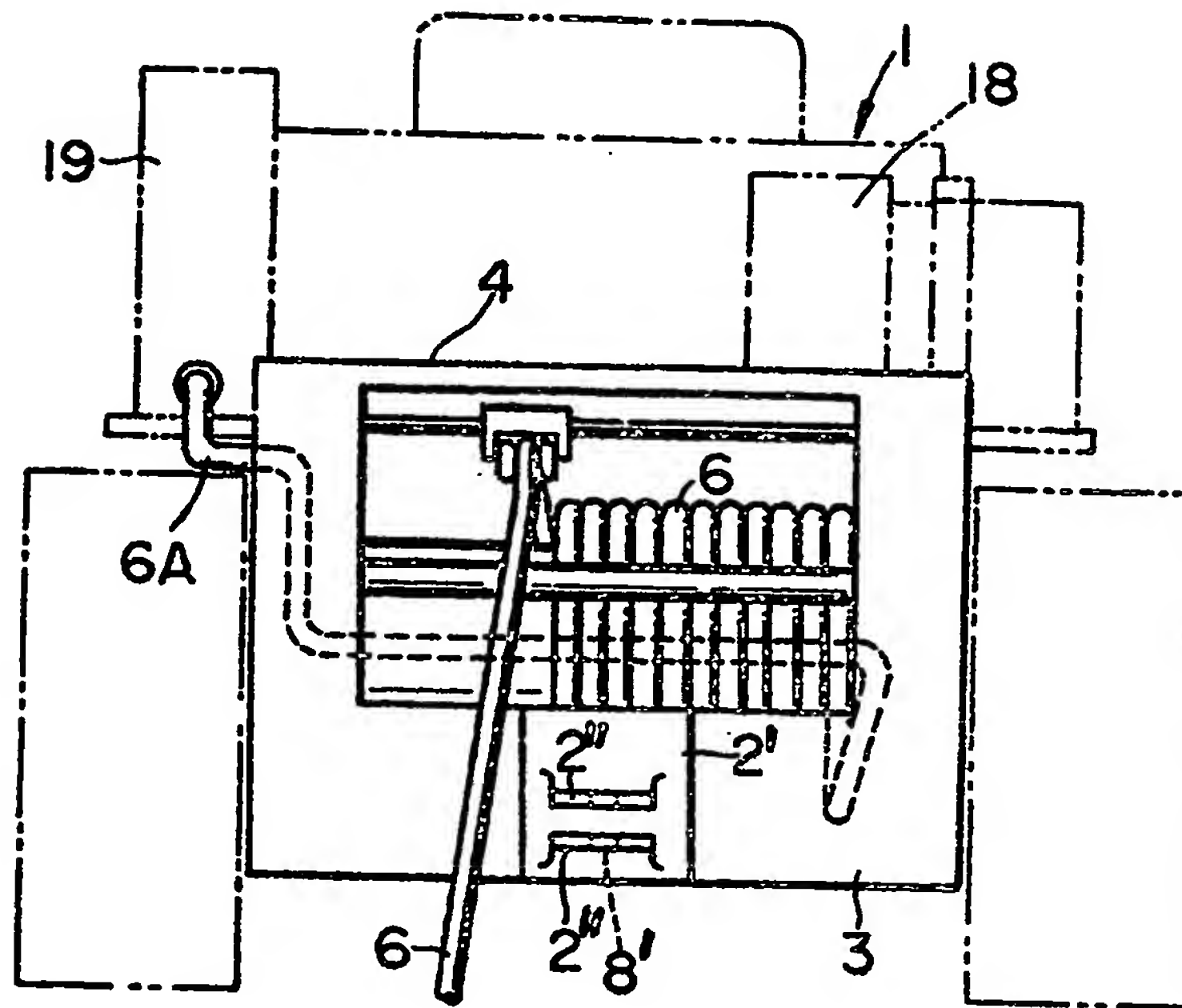
6. The combination of an electrically driven earth-moving machine and an electric source car substantially as hereinbefore 100 described with reference to and as shown by the accompanying drawings.

J. A. KEMP & CO.,  
Chartered Patent Agents,  
14, South Square,  
Gray's Inn,  
London. W.C.1.





*Fig. 2*



*Fig. 3*

